

## Natural Gas Vehicle Technology Forum

### Maximizing Environmental Benefits- A Realistic Evolution:

- Burlington Co. NJ Landfill
- Acrion and Mack Trucks Joint Venture
  - LFG to LNG Truck Fuel,  
pure Liquid CO<sub>2</sub> and Electricity

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# Maximizing Environmental Benefits - A Realistic Evolution:

•Burlington Co. NJ Landfill •Acrion and Mack  
Trucks Joint Venture •LFG to LNG Truck Fuel, pure  
Liquid CO<sub>2</sub> and Electricity

## Outline

- **1. Introduction of the 4 Es**  
**Economics, Energy, Engineering and Environment**  
**What is needed for a realistic evolution to maximize the**  
**benefits to the environment?**
- **2. Acrion CO<sub>2</sub> Wash™ Technology**
- **3. State of the Art of the Burlington Co. Landfill**  
**Letter of Intent**
- **4. Summary of What is Needed to “Make It**  
**Happen”**

# 1. Introduction of the 4 Es

- **Economics, Energy, Engineering and Environment**
- **What is needed for a realistic evolution to maximize the benefits to the environment?**
- **Conflicts and Cooperation Among Vested/Entrenched Interests**
- **Domination by One or Several (But Not All) of the Interests Stops the Realistic Evolution [must keep operating as a coalition]**
- **Maximize benefits to the environment**  
**Reduced LFG greenhouse emissions: CH<sub>4</sub>, CO<sub>2</sub>**  
**Reduced vehicle emissions: NO<sub>x</sub>, CO<sub>2</sub>**  
**Reduced use of (New) fossil fuel by recovery of BTUs**
- **Conflict Examples:**

- **Economics**- Whose “Bottom Line?”
  - 1) Customer (generator of refuse)
  - 2) Landfill Operator
  - 3) Hauler
  - 4) Acrion and other LF infrastructure providers
  - 5) Mack Trucks
- **Energy**- “just right” price of natural gas from conventional sources
 

Low - Recovery of LFG not economical

Too High -

sell the LFG to LNG product (don't use for LNG refuse trucks)
- **Engineering** - “right-sized” LFG to LNG liquefaction modules may have to be designed versus re-design of BIG-BIG chemical and oil refinery liquefaction designs
- **Environment** - who is latest “in-charge” voice in Washington - EPA, DOE?

# Major Point

**Acrion's proof-of-concept demonstration unit at Burlington Co. and Mack's development of a Class 8 heavy duty LNG engine for the refuse truck application has permitted a promising business opportunity for maximizing the benefits to the environment**

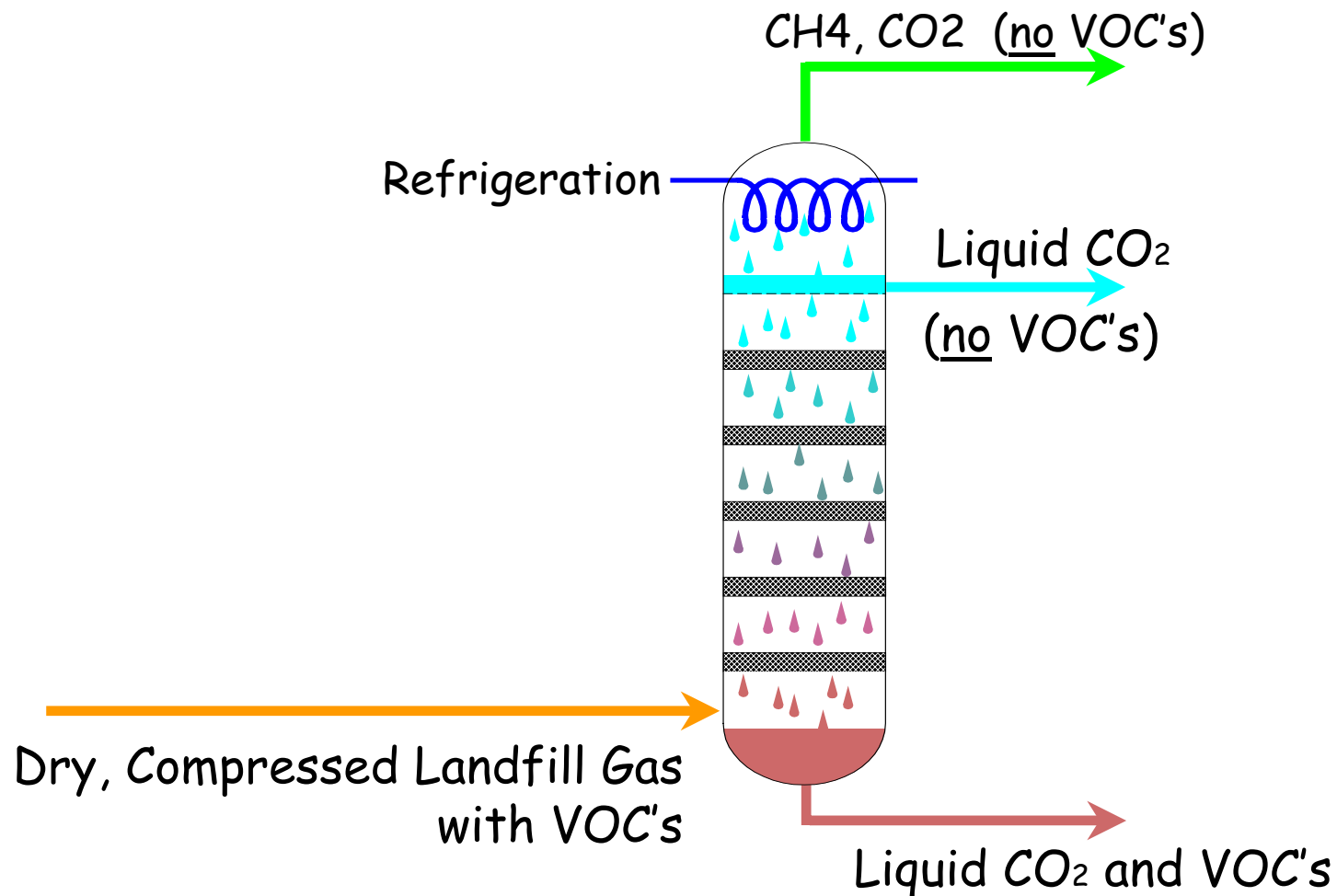
**BUT**

**a melding of interests has to be achieved**

## 2. Acrion CO<sub>2</sub> Wash Technology

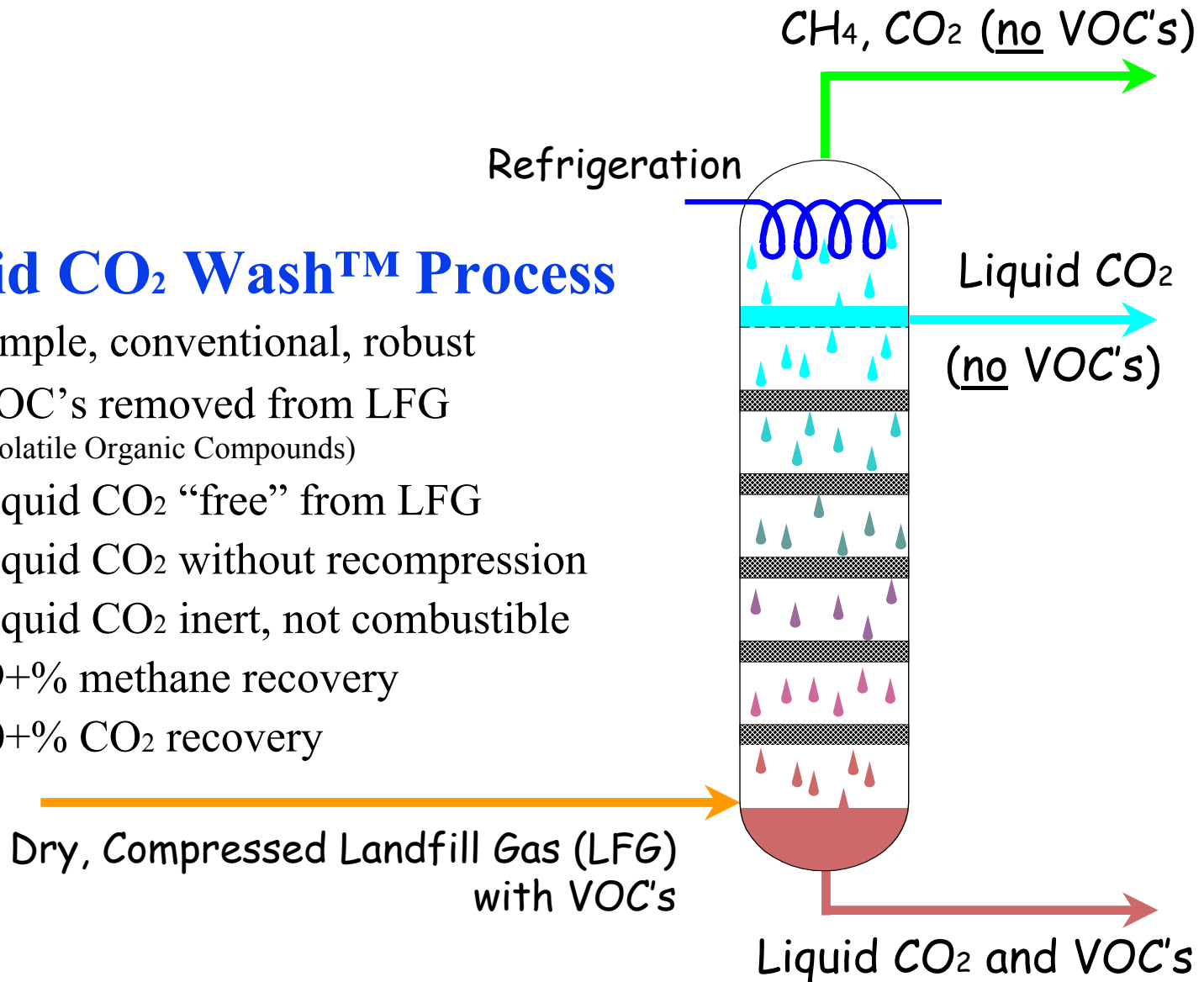
- LFG: CH<sub>4</sub>, CO<sub>2</sub>, N<sub>2</sub>, H<sub>2</sub>O, Trace Contaminants (Cl, F, S, Si, BTX)
- Acrion CO<sub>2</sub> Wash
- LFG to LNG
- LNG Production at NJ EcoComplex
- [www.acrion.com](http://www.acrion.com)

# CO<sub>2</sub> Wash™ Process



## Liquid CO<sub>2</sub> Wash™ Process

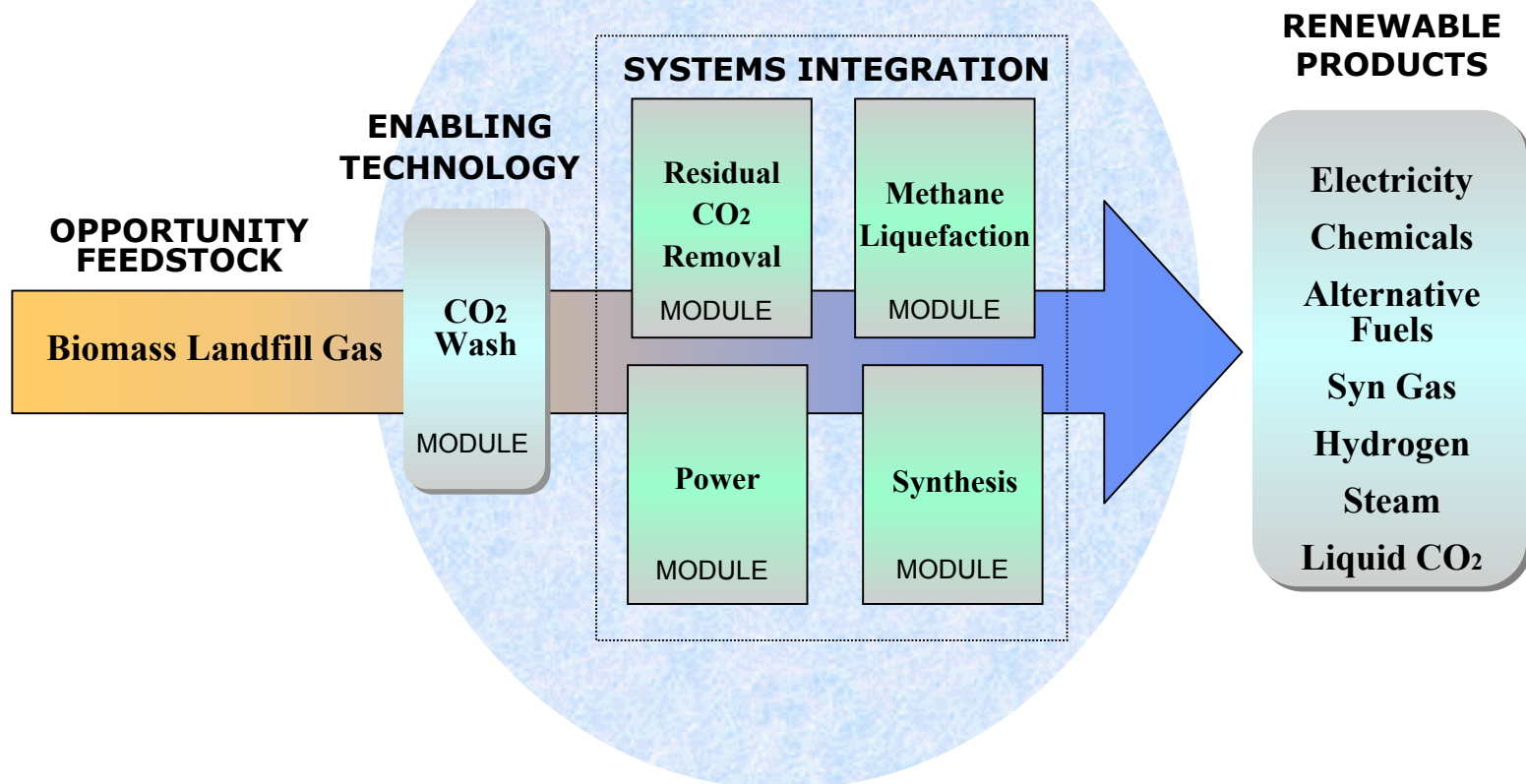
- Simple, conventional, robust
- VOC's removed from LFG  
(Volatile Organic Compounds)
- Liquid CO<sub>2</sub> “free” from LFG
- Liquid CO<sub>2</sub> without recompression
- Liquid CO<sub>2</sub> inert, not combustible
- 99+% methane recovery
- 80+% CO<sub>2</sub> recovery










# CO<sub>2</sub> Wash™ Enabling Technology



# **New Jersey EcoComplex**



## **CO<sub>2</sub> Wash™ Results**

-  Methane Product: < 10 ppb VOC
-  Siloxanes: ND at 5 ppb
-  Liquid CO<sub>2</sub>: > 99.99%

# LFG to LNG



# Auxiliary Equipment for LNG Recovery from LFG



Membranes








Cold Box








LNG Dewar

# Success Ingredients

-  Domestic Renewable Feedstock
-  Complete LFG Utilization
-  Product Flexibility / Mobility
-  Project Replication
-  Proprietary, Patented Technology

# Acknowledgments

-  US DOE NETL / SBIR Program
-  US DOE Brookhaven National Lab
-  New Jersey EcoComplex / Rutgers U
-  Burlington County, NJ
-  Mack Trucks, Allentown, PA

### 3. State of the Art of the Burlington Co. Landfill Letter of Intent

- **Purpose:**  
**Feasibility Study Leading to Project Proposal**  
**LFG to truck fuel + Co-generation plant**
- **Participants:**  
**Burlington Co. Landfill**  
**NJ/Rutgers EcoComplex**  
**NJ Bureau of Public Utilities**  
**Occupational Training Center**  
**Acrion/Mack Trucks + ???**  
**Refuse Haulers**
- **Timing:** can't wait much longer



## 4. Summary of What is Needed to “Make It Happen”

- **Incentives for co-sharing of risk-taking for launching an integrated set of technological innovations**
- **grant with payback for infrastructure capital outlay**
- **fuel-tax waiver + emission tax credits + alternative fuel-tax credits**